CLAIMS

1. A welding apparatus using ultrasonic sensing, comprising:

a movable welder having a selectively adjustable welding head for forming a partially completed weld in a weld seam defined between adjoining metal substrates;

an ultrasonic assembly borne by the moveable welder and which is operable to generate an ultrasonic signal which is directed toward the partially completed weld, and is further reflected from same; and

a controller electrically coupled with the ultrasonic assembly and controllably coupled with the welding head, and wherein the controller receives information regarding the ultrasonic signal and in response to the information optimally positions the welding head relative to the weld seam.

2. An apparatus as claimed in claim 1, wherein the ultrasonic signal is reflected back from the partially completed weld and received by the ultrasonic assembly, and wherein information regarding the received ultrasonic signal is provided to the controller.

3. An apparatus as claimed in claim 1, and further comprising a timing assembly electrically coupled with the controller for calculating a time it takes for the ultrasonic signal to be transmitted and returned to the ultrasonic assembly.

4. An apparatus as claimed in claim 1, and further comprising a timing assembly electrically coupled with the controller for calculating a time it takes for the ultrasonic signal to be transmitted and returned to the ultrasonic assembly, and wherein the time utilized is an average time, and wherein the average time is utilized by the controller to position the welding head to track the partially completed weld.

5. An apparatus as claimed in claim 1, and further comprising a timing assembly electrically coupled with the controller for calculating a time it takes for the ultrasonic signal to be transmitted and returned to the ultrasonic assembly, and wherein the time utilized is an average time, and wherein the average time is utilized to calculate a sound speed, and wherein the sound speed is utilized to position the welding head to track the partially completed weld.

6. An apparatus as claimed in claim 1, and further comprising a timing assembly electrically coupled with the controller for calculating a time it takes for the ultrasonic signal to be transmitted and returned to the ultrasonic assembly, and wherein the controller determines from the time, a width dimension of the partially completed weld.

7. An apparatus as claimed in claim 1, and further comprising a timing assembly electrically coupled with the controller for calculating a time it takes for the ultrasonic signal to be transmitted and returned to the ultrasonic assembly, and

wherein the controller determines from the time, a width dimension of the partially completed weld, and wherein the width dimension is utilized to position the welding head to track the partially completed weld.

8. An apparatus as claimed in claim 1, wherein the ultrasonic signal has two components, a generated signal, and a reflected signal, and wherein the reflected signal is utilized to position the ultrasonic assembly relative to the partially completed weld.

9. An apparatus as claimed in claim 1, wherein the ultrasonic assembly includes at least two ultrasonic assemblies separated by a predetermined distance and located on the same side of the partially completed weld, and wherein the ultrasonic signal is utilized to position the welding head to track the partially completed weld.

10. An apparatus as claimed in claim 1, wherein the ultrasonic assembly includes at least two ultrasonic assemblies separated by a predetermined distance and individually located on opposite sides of the partially completed weld, and wherein the ultrasonic signal is utilized to position the welding head to track the partially completed weld.

11. A welding apparatus using ultrasonic sensing, comprising:

a moveable welder having a selectively adjustable welding head for forming a partially completed weld in a weld seam defined between adjoining metal substrates;

an ultrasonic assembly borne by the moveable welder for generating an ultrasonic signal which is directed toward the partially completed weld, and wherein the ultrasonic signal strikes the partially completed weld and is reflected back in the direction of the ultrasonic assembly;

a timing assembly for calculating a time it takes for the ultrasonic signal to be transmitted and returned to the ultrasonic assembly; and

a controller electrically coupled with the timing assembly, and which determines from the time, a distance that the ultrasonic assembly is from the partially completed weld.

12. An apparatus as claimed in claim 11, wherein the distance determined from the time is utilized to position the ultrasonic assembly relative to the partially completed weld.

13. An apparatus as claimed in claim 11, wherein the time is utilized to position the welding head to track the partially completed weld.

14. An apparatus as claimed in claim 11, wherein the controller determines from the time, a width dimension of the partially completed weld.

15. An apparatus as claimed in claim 11, wherein the controller determines from the time, a width dimension of the partially completed weld, and wherein the width dimension is utilized to position the welding head to track the partially completed weld.

16. An apparatus as claimed in claim 11, wherein the ultrasonic signal has two components, a generated signal, and a reflected signal, and wherein the reflected signal is utilized to position the ultrasonic assembly relative to the partially completed weld.

17. An apparatus as claimed in claim 11, wherein the time utilized is an average time, and wherein the average time is utilized to calculate a sound speed, and wherein the sound speed is utilized to position the ultrasonic assembly relative to the partially completed weld.

18. An apparatus as claimed in claim 11, wherein the time utilized is an average time, and wherein the average time is utilized to calculate a sound speed, and wherein the sound speed is utilized to position the welding head to track the partially completed weld.

19. An apparatus as claimed in claim 11, wherein the ultrasonic assembly includes at least two ultrasonic assemblies separated by a predetermined distance

and located on the same side of the partially completed weld, and wherein the ultrasonic signal is utilized to position the at least two ultrasonic assemblies relative to the partially completed weld.

20. An apparatus as claimed in claim 11, wherein the ultrasonic assembly includes at least two ultrasonic assemblies separated by a predetermined distance and located on the same side of the partially completed weld, and wherein the ultrasonic signal is utilized to position the welding head to track the partially completed weld.

21. An apparatus as claimed in claim 11, wherein the ultrasonic assembly includes at least two ultrasonic assemblies separated by a predetermined distance and individually located on opposite sides of the partially completed weld, and wherein the ultrasonic signal is utilized to position the at least two ultrasonic assemblies relative to the partially completed weld.

22. An apparatus as claimed in claim 11, wherein the ultrasonic assembly includes at least two ultrasonic assemblies separated by a predetermined distance and individually located on opposite sides of the partially completed weld, and wherein the ultrasonic signal is utilized to position the welding head to track the partially completed weld.

23. An apparatus as claimed in claim 11, wherein the ultrasonic assembly includes at least two ultrasonic assemblies separated by a predetermined distance and individually located on opposite sides of the partially completed weld, and wherein the time utilized is an average time, and wherein the average time is utilized to position the at least two ultrasonic assemblies relative to the partially completed weld.

24. An apparatus as claimed in claim 11, wherein the ultrasonic assembly includes at least two ultrasonic assemblies separated by a predetermined distance and individually located on opposite sides of the partially completed weld, and wherein the time utilized is an average time, and wherein the average time is utilized to position the welding head to track the partially completed weld.

25. An apparatus as claimed in claim 11, wherein the ultrasonic assembly includes at least two ultrasonic assemblies separated by a predetermined distance and individually located on opposite sides of the partially completed weld, and wherein the time utilized is an average time, and wherein the average time is utilized to calculate a width dimension of the partially completed weld.

26. An apparatus as claimed in claim 11, wherein the partially completed weld has a corner, and wherein the ultrasonic signal strikes the corner and is reflected back in the direction of the ultrasonic assembly.

27. An apparatus as claimed in claim 11, wherein the partially completed weld has a corner, and wherein the time is utilized by the controller to calculate the distance between the ultrasonic assembly and the corner.

28. An apparatus as claimed in claim 11, wherein the partially completed weld has a sidewall, and wherein the ultrasonic signal strikes the sidewall and is reflected back in the direction of the ultrasonic assembly.

29. An apparatus as claimed in claim 11, wherein the partially completed weld has a sidewall, and wherein the time is utilized by the controller to calculate the distance between the ultrasonic assembly and the sidewall.

30. An apparatus as claimed in claim 11, wherein the partially completed weld has a root, and wherein the ultrasonic signal strikes the root and is reflected back in the direction of the ultrasonic assembly.

31. An apparatus as claimed in claim 11, wherein the partially completed weld has a root, and wherein the time is utilized by the controller to calculate the distance between the ultrasonic assembly and the root.

32. An apparatus as claimed in claim 11, wherein the ultrasonic signal utilized is a surface wave.

33. An apparatus as claimed in claim 11, wherein the ultrasonic signal utilized is a shear wave.

34. A welding apparatus using ultrasonic sensing, comprising:

a moveable welder having a selectively adjustable welding head for forming a partially completed weld in a weld seam defined between adjoining metal substrates;

an ultrasonic assembly borne by the moveable welder for generating an ultrasonic signal along a surface of the metal substrates, and which is directed toward the partially completed weld, and wherein the ultrasonic signal strikes the partially completed weld and is reflected back in the direction of the ultrasonic assembly;

a timing assembly for calculating a time it takes for the ultrasonic signal to be transmitted and returned to the ultrasonic assembly; and

a controller electrically coupled with the timing assembly and which utilizes the time to calculate a distance that the ultrasonic generator is from the partially completed weld.

35. An apparatus as claimed in claim 34, wherein the distance calculated using the time is utilized to position the ultrasonic assembly relative to the partially completed weld.

36. An apparatus as claimed in claim 34, wherein the time is utilized by the controller to optimally position the welding head to track the partially completed weld.

37. An apparatus as claimed in claim 34, wherein the controller determines from the time, a width dimension of the partially completed weld.

38. An apparatus as claimed in claim 34, wherein the controller determines from the time, a width dimension of the partially completed weld, and wherein the width dimension of the partially completed weld is utilized to position the welding head to track the partially completed weld.

39. An apparatus as claimed in claim 34, wherein the ultrasonic signal has two components, a generated signal, and a reflected signal, and wherein the reflected signal is utilized to position the ultrasonic assembly relative to the partially completed weld.

40. An apparatus as claimed in claim 34, wherein the time utilized is an average time, and wherein the average time is utilized to calculate a sound speed, and wherein the sound speed is utilized to position the ultrasonic assembly relative to the partially completed weld.

41. An apparatus as claimed in claim 34, wherein the time utilized is an average time, and wherein the average time is utilized to calculate a sound speed, and wherein the sound speed is utilized to position the welding head to track the partially completed weld.

42. An apparatus as claimed in claim 34, wherein the ultrasonic assembly includes at least two ultrasonic assemblies separated by a predetermined distance and located on the same side of the partially completed weld, and wherein the ultrasonic signal is utilized to position the at least two ultrasonic assemblies relative to the partially completed weld.

43. An apparatus as claimed in claim 34, wherein the ultrasonic assembly includes at least two ultrasonic assemblies separated by a predetermined distance and located on the same side of the partially completed weld, and wherein the ultrasonic signal is utilized to position the welding head to track the partially completed weld.

44. An apparatus as claimed in claim 34, wherein the ultrasonic assembly includes at least two ultrasonic assemblies separated by a predetermined distance and individually located on opposite sides of the partially completed weld, and wherein the ultrasonic signal is utilized to position the at least two ultrasonic assemblies relative to the partially completed weld.

45. An apparatus as claimed in claim 34, wherein the ultrasonic assembly includes at least two ultrasonic assemblies separated by a predetermined distance and individually located on opposite sides of the partially completed weld, and wherein the ultrasonic signal is utilized to position the welding head to track the partially completed weld.

46. An apparatus as claimed in claim 34, wherein the ultrasonic assembly includes at least two ultrasonic assemblies separated by a predetermined distance and individually located on opposite sides of the partially completed weld, and wherein the time utilized is an average time, and wherein the average time is utilized to position the at least two ultrasonic assemblies relative to the partially completed weld.

47. An apparatus as claimed in claim 34, wherein the ultrasonic assembly includes at least two ultrasonic assemblies separated by a predetermined distance and individually located on opposite sides of the partially completed weld, and wherein the time utilized is an average time, and wherein the average time is utilized to position the welding head to track the partially completed weld.

48. An apparatus as claimed in claim 34, wherein the ultrasonic assembly includes at least two ultrasonic assemblies separated by a predetermined distance and individually located on opposite sides of the partially completed weld, and

wherein the time utilized is an average time, and wherein the average time is utilized to calculate a width dimension of the partially completed weld.

49. An apparatus as claimed in claim 34, wherein the partially completed weld has a corner, and wherein the ultrasonic signal strikes the corner and is reflected back in the direction of the ultrasonic assembly.

50. An apparatus as claimed in claim 34, wherein the partially completed weld has a corner, and wherein the time is utilized by the controller to calculate the distance between the ultrasonic assembly and the corner.

51. An apparatus as claimed in claim 34, wherein the partially completed weld has a sidewall, and wherein the ultrasonic signal strikes the sidewall and is reflected back in the direction of the ultrasonic assembly.

52. An apparatus as claimed in claim 34, wherein the partially completed weld has a sidewall, and wherein the time is utilized by the controller to calculate the distance between the ultrasonic assembly and the sidewall.

53. A welding apparatus using ultrasonic sensing, comprising:

a movable welder having a selectively adjustable welding head for forming a partially completed weld in a metal substrate;

an ultrasonic assembly borne by the moveable welder for generating an ultrasonic signal which is directed toward the partially completed weld, and wherein the ultrasonic signal is reflected off a bottom surface of the metal substrate before striking the partially completed weld, and wherein the ultrasonic signal strikes the partially completed weld and is reflected back in the direction of the ultrasonic assembly;

a timing assembly for calculating a time it takes for the ultrasonic signal to be transmitted and returned to the ultrasonic assembly; and

a controller electrically coupled with the timing assembly and determining from the time, a distance that the ultrasonic assembly is from the partially completed weld.

54. An apparatus as claimed in claim 53, wherein the distance determined from the time is utilized to position the ultrasonic assembly relative to the partially completed weld.

55. An apparatus as claimed in claim 53, wherein the time is utilized by the controller to optimally position the welding head to track the partially completed weld.

56. An apparatus as claimed in claim 53, wherein the controller determines from the time, a width dimension of the partially completed weld.

57. An apparatus as claimed in claim 53, wherein the controller determines from the time, a width dimension of the partially completed weld, and wherein the width dimension of the partially completed weld is utilized to position the welding head to track the partially completed weld.

58. An apparatus as claimed in claim 53, wherein the ultrasonic signal has two components, a generated signal, and a reflected signal, and wherein the reflected signal is utilized to position the ultrasonic assembly relative to the partially completed weld.

59. An apparatus as claimed in claim 53, wherein the time utilized is an average time, and wherein the average time is utilized to calculate a sound speed, and wherein the sound speed is utilized to position the ultrasonic assembly relative to the partially completed weld.

60. An apparatus as claimed in claim 53, wherein the time utilized is an average time, and wherein the average time is utilized to calculate a sound speed, and wherein the sound speed is utilized to position the welding head to track the partially completed weld.

61. An apparatus as claimed in claim 53, wherein the ultrasonic assembly includes at least two ultrasonic assemblies separated by a predetermined distance

and located on the same side of the partially completed weld, and wherein the ultrasonic signal is utilized to position the at least two ultrasonic assemblies relative to the partially completed weld.

62. An apparatus as claimed in claim 53, wherein the ultrasonic assembly includes at least two ultrasonic assemblies separated by a predetermined distance and located on the same side of the partially completed weld, and wherein the ultrasonic signal is utilized to position the welding head to track the partially completed weld.

63. An apparatus as claimed in claim 53, wherein the ultrasonic assembly includes at least two ultrasonic assemblies separated by a predetermined distance and individually located on opposite sides of the partially completed weld, and wherein the ultrasonic signal is utilized to position the at least two ultrasonic assemblies relative to the partially completed weld.

64. An apparatus as claimed in claim 53, wherein the ultrasonic assembly includes at least two ultrasonic assemblies separated by a predetermined distance and individually located on opposite sides of the partially completed weld, and wherein the ultrasonic signal is utilized to position the welding head to track the partially completed weld.

65. An apparatus as claimed in claim 53, wherein the ultrasonic assembly includes at least two ultrasonic assemblies separated by a predetermined distance and individually located on opposite sides of the partially completed weld, and wherein the time utilized is an average time, and wherein the average time is utilized to position the at least two ultrasonic assemblies relative to the partially completed weld.

66. An apparatus as claimed in claim 53, wherein the ultrasonic assembly includes at least two ultrasonic assemblies separated by a predetermined distance and individually located on opposite sides of the partially completed weld, and wherein the time utilized is an average time, and wherein the average time is utilized to position the welding head to track the partially completed weld.

67. An apparatus as claimed in claim 53, wherein the ultrasonic assembly includes at least two ultrasonic assemblies separated by a predetermined distance and individually located on opposite sides of the partially completed weld, and wherein the time utilized is an average time, and wherein the average time is utilized to calculate a width dimension of the partially completed weld.

68. An apparatus as claimed in claim 53, wherein the partially completed weld has a corner, and wherein the ultrasonic signal strikes the corner and is reflected back in the direction of the ultrasonic assembly.

69. An apparatus as claimed in claim 53, wherein the partially completed weld has a corner, and wherein the time is utilized by the controller to calculate the distance between the ultrasonic assembly and the corner.

70. An apparatus as claimed in claim 53, wherein the partially completed weld has a sidewall, and wherein the ultrasonic signal strikes the sidewall of the partially completed weld and is reflected back in the direction of the ultrasonic assembly.

71. An apparatus as claimed in claim 53, wherein the partially completed weld has a sidewall, and wherein the time is utilized by the controller to calculate the distance between the ultrasonic assembly and the sidewall.

72. An apparatus as claimed in claim 53, wherein the partially completed weld has a root, and wherein the ultrasonic signal strikes the root and is reflected back in the direction of the ultrasonic assembly.

73. An apparatus as claimed in claim 53, wherein the partially completed weld has a root, and wherein the time is utilized by the controller to calculate the distance between the ultrasonic assembly and the root.

74. A welding method using ultrasonic sensing, comprising:

providing a moveable welder having a selectively adjustable welding head for forming a partially completed weld;

providing an ultrasonic assembly borne by the moveable welder for generating an ultrasonic signal which is directed toward the partially completed weld, and wherein the ultrasonic signal strikes the partially completed weld and is reflected back in the direction of the ultrasonic assembly;

calculating a time that it takes for the ultrasonic signal to be transmitted and returned to the ultrasonic assembly; and

determining from the time, a distance that the welding head is from the partially completed weld.

75. A method as claimed in claim 74, wherein the partially completed weld is formed in a weld seam defined between adjoining metal substrates having a bottom surface, and wherein the ultrasonic signal is reflected off the bottom surface of the metal substrate before striking the partially completed weld.

76 A method as claimed in claim 74, wherein the method further comprises:

using the distance determined from the time to position the ultrasonic assembly relative to the partially completed weld.

77. A method as claimed in claim 74, wherein the method further comprises:

using the time to position the welding head to track the partially completed weld.

78. A method as claimed in claim 74, wherein the method further comprises:

determining from the time, a width dimension of the partially completed weld.

79. A method as claimed in claim 74, wherein the method further comprises:

determining from the time, a width dimension of the partially completed weld, and utilizing the width dimension to position the welding head to track the partially completed weld.

80. A method as claimed in claim 74, wherein the ultrasonic signal generated by the ultrasonic assembly has two components, a generated signal, and a reflected signal, and wherein the reflected signal is utilized to position the ultrasonic assembly relative to the partially completed weld.

81. A method as claimed in claim 74, wherein the time utilized is an average time, and wherein the average time is utilized to calculate a sound speed, and wherein the sound speed is utilized to position the ultrasonic assembly relative to the partially completed weld.

82. A method as claimed in claim 74, wherein the time utilized is an average time, and wherein the average time is utilized to calculate a sound speed, and wherein the sound speed is utilized to position the welding head to track the partially completed weld.

83. A method as claimed in claim 74, wherein the providing an ultrasonic assembly further comprises:

providing at least two ultrasonic assemblies separated by a predetermined distance and located on the same side of the partially completed weld, and wherein the ultrasonic signal is utilized to position the at least two ultrasonic assemblies relative to the partially completed weld.

84. A method as claimed in claim 74, wherein the providing an ultrasonic assembly further comprises:

providing at least two ultrasonic assemblies separated by a predetermined distance and located on the same side of the partially completed weld, and wherein the ultrasonic signal is utilized to position the welding head to track the partially completed weld.

85. A method as claimed in claim 74, wherein the providing an ultrasonic assembly further comprises:

providing at least two ultrasonic assemblies separated by a predetermined distance and individually located on opposite sides of the partially completed weld,

and wherein the ultrasonic signal is utilized to position the at least two ultrasonic assemblies relative to the partially completed weld.

86. A method as claimed in claim 74, wherein the providing an ultrasonic assembly further comprises:

providing at least two ultrasonic assemblies separated by a predetermined distance and individually located on opposite sides of the partially completed weld, and wherein the ultrasonic signal is utilized to position the welding head to track the partially completed weld.

87. A method as claimed in claim 74, wherein the providing an ultrasonic assembly further comprises:

providing at least two ultrasonic assemblies separated by a predetermined distance and individually located on opposite sides of the partially completed weld, and wherein the time utilized is an average time, and wherein the average time is utilized to position the at least two ultrasonic assemblies relative to the partially completed weld.

88. A method as claimed in claim 74, wherein the providing an ultrasonic assembly further comprises:

providing at least two ultrasonic assemblies separated by a predetermined distance and individually located on opposite sides of the partially completed weld,

and wherein the time utilized is an average time, and wherein the average time is utilized to position the welding head to track the partially completed weld.

89. A method as claimed in claim 74, wherein the providing an ultrasonic assembly further comprises:

providing at least two ultrasonic assemblies separated by a predetermined distance and individually located on opposite sides of the partially completed weld, and wherein the time utilized is an average time, and wherein the average time is utilized to calculate a width dimension of the partially completed weld.

90. A method as claimed in claim 74, wherein the partially completed weld has a corner, and wherein the ultrasonic signal which is directed toward the partially completed weld strikes the corner and is reflected back in the direction of the ultrasonic assembly.

91. A method as claimed in claim 74, wherein the partially completed weld has a sidewall, and wherein the ultrasonic signal which is directed toward the partially completed weld strikes the sidewall and is reflected back in the direction of the ultrasonic assembly.

92. A method as claimed in claim 74, wherein the partially completed weld has a root, and wherein the ultrasonic signal which is directed toward the

partially completed weld strikes the root and is reflected back in the direction of the ultrasonic assembly.

ABSTRACT OF THE DISCLOSURE